FUEL CELL WITH FUEL SUPPLY DEVICE AND METHOD FOR PRODUCING THE SAME

Detailed Action

1. The amendments filed on January 4, 2010 were received. Applicant has amended claims 1-4, 12, 14 and 23. Claims 1-23 and 25 are pending.

2. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Terminal Disclaimer

3. The terminal disclaimer, filed on January 4, 2010, does not comply with 37 CFR 1.321(b) and/or (c) because: The words "legal title" do not include common ownership as to equitable title.

Claim Rejections - 35 USC § 112

5. The rejection of claims 2, 3, 4, 12, 14-23 and 25 under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention, is withdrawn because claims 2, 3, 4, 12, 14 and 23 were amended.

6. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

7. Claims 12 and 23 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the

specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

Regarding claim 12, upon review of the instant specification, there does not appear to support of the limitation recited with respect to positioning a fuel cell sensor in the reservoir.

Regarding claim 23, upon review of the instant specification, there does not appear to be support for the limitation recited with respect to measuring the resistance of the reservoir.

Claim Rejections - 35 USC § 103

10. Claims 1-10 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jankowski et al. (US 2003/0039874) in view of Tanaka (US 2002/0076586). Additional supporting evidence provided by *Collins Dictionary of Computing.*

Regarding claims 1, 2, 4, 5 and 8, Jankowski teaches a micro-electro-mechanical systems (MEMS) based thin-film fuel cells, combined with full-integrated control circuitry, for electrical power applications (Abstract; para 7). Each MEMS-based fuel cell includes an anode; a cathode; an electrolyte layer separating the electrodes (e.g., a solid oxide or solid polymer material, or proton exchange membrane electrolyte materials); and, a host structure (or substrate) composed of materials such as silicon, glass, ceramic, or plastic fabricated using silicon micromachining techniques (Abstract; para. 30, 31, 32; Figs. 1, 2). The cell may incorporate a fuel reservoir (containing hydrogen) as part of a package approach where the reservoir may be a volume containing a metal hydride or other material which is capable of storing hydrogen within it (and include some form of integrated microvalves placed in its micro-flow channels as a means of controlling the flow of fuel) (para. 18). As shown in Fig. 2, Jankowski depicts a fuel channel 29 (in communication with an electrode 25 and a fuel inlet 15 connected to the fuel reservoir) and an oxidant channel 30 (in communication with an electrode 27 and an oxidant inlet 17 enabling the flow of ambient air) (para. 32, 46; Fig. 2).

Jankowski does not expressly teach that the fuel is integrated in the material of at least one of the first electrode and an adjacent layer.

Tanaka teaches a fuel cell, usable in portable devices, with a fuel electrode assembly composed of a fuel electrode surrounded by a hydrogen absorber acting as a fuel source (Abstract; para. 53, 54, 55).

It would have been obvious to one of ordinary skill in the art at the time of the invention to incorporate a layer of material having fuel integrated therein onto an anode of the fuel cell of Jankowski because Tanaka teaches that this material can serve as a reservoir of fuel when the initial fuel source is not available (see Tanaka, para. 27, 28).

Regarding claim 3, Jankowski teaches that that an electrode may be composed of palladium (para. 41).

Regarding claims 6 and 7, Jankowski teaches that the electrical current generated from each cell is drawn away with an interconnect and support structure integrated with the gas manifold fabricated using integrated circuit type micro-fabrication processes (Abstract; para. 33).

Jankowski does not expressly teach that its integrated circuit is a CMOS circuit.

One of ordinary skill in the art would readily appreciate that CMOS is a form of construction for integrated circuits that requires very low power inputs and is now being extensively used both for microprocessors and for memories (see "CMOS" from *Collins Dictionary of Computing*). Therefore, this limitation has not been given patentable weight since the method of forming the device is not germane to the issue of patentability of the device itself. However, one of ordinary skill in the art would also appreciate that the electrical circuit of Jankowski, as modified by Tanaka, can be constructed using CMOS methodology because Jankowski teaches that this circuit is produced using integrated circuit type micro-fabrication processes.

Regarding claim 9, Jankowski teaches that the fuel cell has integrated control circuitry, as discussed above. The reference also teaches that that the fuel cell has an integrated resistive heater (and a

micro-battery) used to heat up the fuel cell during start-up (para. 7, 11, 18 and 49). One of ordinary skill in the art would appreciate that the integrated control circuitry of the fuel cell of Jankowski, as modified by Tanaka, will control components of the cell employed during start-up.

Regarding claim 10, Jankowski teaches that the use of MEMS processes to fabricate the fuel cell allows for individual control of gas flow using microvalves as well as the control and regulation of gas pressure or fuel flow throughout the device (para. 31).

Regarding claim 13, Jankowski teaches a thin-film fuel cells, fabricated using MEMS processes and combined with full-integrated control circuitry, for electrical power applications (Abstract; para 7). Each MEMS-based fuel cell includes an anode and a cathode separated by an electrolyte layer (e.g., a solid oxide or solid polymer material, or proton exchange membrane electrolyte materials (Abstract; para. 30, 32; Figs. 1, 2).

Jankowski does not expressly teach that the fuel delivery device is configured as an integral part of one of the electrodes; or, treating the material of the fuel delivery device with fuel.

Tanaka teaches a fuel cell, usable in portable devices, with a fuel electrode assembly composed of a fuel electrode surrounded by a hydrogen absorber acting as a fuel source (Abstract; para. 53, 54, 55). The hydrogen absorber absorbs and supports hydrogen that has been supplied from an external source (para. 54).

Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to integrate a treated, fuel delivery device with an anode of the fuel cell formed by the method of Jankowski because Tanaka teaches that fuel can be delivered to the electrode when an initial fuel source is not available, or when an external fuel source is not desirable (see Tanaka, para. 27, 28).

11. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Jankowski et al. and Tanaka as applied to claims 1-10 and 13 above, and further in view of Mukerjee et al. (US 2002/0168560).

Jankowski and Tanaka are applied and incorporated herein for the reasons above.

Regarding claim 11, Jankowski teaches that the individual fuel cells may be incorporated into a module as a means of scaling power and voltage (para. 16). Jankowski and Tanaka do not expressly teach that the fuel cell is configured as a replaceable module.

Mukerjee teaches that a modular configuration of fuel cells permits the arrangement of the cells to be easily adjusted to meet specific physical design criteria, such as, for example, a particular packaging arrangement (para. 49). In addition, the modules can be serviced or replaced individually, and making maintenance easier by avoiding the disassembly of a fuel cell assembly (para. 49).

It would have been obvious to one of ordinary skill in the art at the time of the invention to make the fuel cell of Jankowski, as modified by Tanaka, a replaceable module because Mukerjee teaches that its eases the process of adjusting the arrangement of cells to the accommodate the size of the unit they are to be used, and improves the ease of cell maintenance.

12. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Jankowski et al. and Tanaka et al. as applied to claims 1-11 and 13 above, and further in view of Uchida et al. (US 6,057,051).

Jankowski and Tanaka are applied and incorporated herein for the reasons above.

Regarding claim 12, Jankowski and Tanaka do not expressly teach a fuel sensor that is positioned in at least one of the reservoir and the reaction region (including a region between protons and the reactant), the sensor being configured to determine an available amount of fuel or reactant.

Uchida teaches methods of detecting an operating time of the fuel cell including a method of using a pressure sensor for detecting an amount of the hydrogen remaining in a hydrogen storage unit, a

method of detecting an accumulated flow rate of the hydrogen, a method of integrating an amount of the generated electricity to find an amount of reaction of the hydrogen to thereby calculate an amount of the remaining hydrogen, and a method of detecting an amount of the formed water by the above-mentioned method to calculate an amount of consumption of the hydrogen (7:39-48).

It would have been obvious to one of ordinary skill in the art at the time of the invention to place a fuel sensor in the reservoir employed in the fuel cell of Jankowski, as modified by Tanaka, because Uchida teaches that the sensor allows the user of a device powered by the fuel cell to estimate the operating time the device has remaining (see Uchida, 7:39-40).

13. Claims 14-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jankowski et al. and Tanaka as applied to claims 1-13 above, and further in view of Keppeler (US 2002/0098399) and Sakai et al. (JP 02-098067 A).

Jankowski and Tanaka are applied and incorporated herein for the reasons above.

Regarding claims 14 and 16, Jankowski also teaches, as shown in Fig. 2, a fuel channel 29 (in communication with an electrode 25 and a fuel inlet 15 connected to the fuel reservoir) and an oxidant channel 30 (in communication with an electrode 27 and an oxidant inlet 17 enabling the flow of ambient air) (para. 32, 46; Fig. 2), as discussed above.

Jankowski does not expressly teach that the integration of reactant (for generating a given amount of current) into the material of at least one of the second electrode and an adjacent layer; or, that oxygen is integrated into the reactant delivery device.

Keppeler also teaches that its fuel cell has a cathode space 3 containing an easily oxidizable compound (or substance) that, when the fuel cell is operated without any additional supply of hydrogen or air, leads to an reduction reaction in the cathode space which produces oxygen (Abstract; para. 27-28). Further, Sakai teaches an electrochemical cell incorporating a hydrogen storage alloy for a negative

electrode, an oxygen storage (positive) electrode formed of a predetermined metal composite oxide, and inlets for hydrogen and oxygen to be fed to respective sides of the cell, that achieves compactness, lower cost, and makes maintenance unnecessary.

Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to incorporate a reactant storage material into the second electrode of the fuel cell of Jankowski, as modified by Tanaka, or material adjacent thereto, where that material participates in reactant delivery to the cell, because Keppeler teaches that it can facilitate operation of the cell without providing reactant, such as oxygen (see also Keppeler, para. 13, 28), similar to the teachings of Tanaka discussed above; and, Sakai teaches that use of a reactant storing material in an electrochemical cell can facilitate in forming a compact, lower-maintenance cell.

The remaining limitations recited in this claim have been discussed above with respect to claim 1.

Regarding claims 15, 17, 18, 19 and 20, this limitation has been addressed above with respect to claims 5, 6, 7, 8, 9 and 10.

14. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Jankowski et al., Tanaka, Sakai et al. and Keppeler as applied to claims 14-20 above, and further in view of Mukerjee et al. (US 2002/0168560).

Jankowski, Tanaka, Keppeler and Sakai are applied and incorporated herein for the reasons above.

Regarding claim 21, Jankowski teaches that the individual fuel cells may be incorporated into a module as a means of scaling power and voltage (para. 16). Jankowski, Tanaka, Keppeler and Sakai do not expressly teach that the fuel cell is configured as a replaceable module.

Mukerjee teaches that a modular configuration of fuel cells permits the arrangement of the cells to be easily adjusted to meet specific physical design criteria, such as, for example, a particular packaging

arrangement (para. 49). In addition, the modules can be serviced or replaced individually, and making maintenance easier by avoiding the disassembly of a fuel cell assembly (para. 49).

It would have been obvious to one of ordinary skill in the art at the time of the invention to make the fuel cell of Jankowski, as modified by Tanaka, Keppeler and Sakai, a replaceable module because Mukerjee teaches that its eases the process of adjusting the arrangement of cells to the accommodate the size of the unit they are to be used, and improves the ease of cell maintenance.

15. Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Jankowski et al., Tanaka, Sakai et al. and Keppeler et al. as applied to claims 14-21 above, and further in view of Uchida et al. (US 6,057,051).

Jankowski, Tanaka, Keppeler and Sakai are applied and incorporated herein for the reasons above.

Regarding claim 22, Jankowski, Tanaka, Keppeler and Sakai do not expressly teach a reactant sensor that is positioned in at least one of the fuel or reactant delivery devices and the reaction region (including a region between protons and the reactant), the sensor being configured to determine an available amount of fuel or reactant.

Uchida teaches methods of detecting an operating time of the fuel cell including a method of using a pressure sensor for detecting an amount of the hydrogen remaining in a hydrogen storage unit, a method of detecting an accumulated flow rate of the hydrogen, a method of integrating an amount of the generated electricity to find an amount of reaction of the hydrogen to thereby calculate an amount of the remaining hydrogen, and a method of detecting an amount of the formed water by the above-mentioned method to calculate an amount of consumption of the hydrogen (7:39-48). As to a *reactant* sensor (emphasis added), although Uchida does not expressly teach a method with respect to the reactant

available to a fuel cell, one of ordinary skill in the art would appreciate that the methods described by Uchida can be applied to the reactant (e.g., O_2, etc.) of a fuel cell.

It would have been obvious to one of ordinary skill in the art at the time of the invention to place a reactant sensor in the reactant delivery device used in the fuel cell of Jankowski, as modified by Tanaka, Keppeler and Sakai, in the manner taught by Uchida to allow the user of a device powered by the fuel cell to estimate the operating time the device has remaining (see Uchida, 7:39-40), as discussed above.

16. Claims 23 and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jankowski et al., Tanaka, Sakai et al. and Keppeler et al. as applied to claims 14-22 above, and further in view of Anderten et al. (US 4,164,172).

Jankowski, Tanaka, Keppeler and Sakai are applied and incorporated herein for the reasons above.

Regarding claim 23, Jankowski, Tanaka, Keppeler and Sakai do not expressly teach a circuit for at least one of measuring the resistance of the reservoir and of the reactant delivery device, and for determining the remaining amount of one of fuel and reactant.

Anderten teaches a fuel cell 36 connected to an oxygen control circuit 34, which employs a FET (field effect transistor) to measure the resistance in the circuit, that controls the amount of oxygen made available to the cell dependent upon the magnitude of the current produced by the cell (Abstract; 4:16-33, 4:45-58, 4:59-5:3, 5:21-36; Fig. 3). One of ordinary skill in the art would appreciate that the methods described by Anderten can also be applied to the fuel (e.g., H_2, etc.) supplied to a fuel cell.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to use a circuit to measure the resistance of the reservoir or the reactant delivery device used in the fuel cell of Jankowski, as modified by Tanaka, Keppeler and Sakai, because Anderten teaches that it provides a means with which to control the amount of fuel or reactant made available to its fuel cell.

Regarding claim 25, Jankowski, Tanaka, Keppeler and Sakai do not expressly teach a measuring device configured to determine at least one of a current and a voltage generated by reaction between the fuel and the reactant.

Anderten also teaches that the oxygen control circuit 36 discussed above responds to predetermined maximum and minimum voltage levels corresponding to maximum and minimum oxygen partial pressures of the air made available to the fuel cell 36 (4:59-3, 5:49-6:43). Also, as discussed above, one of ordinary skill in the art would appreciate that above-described method of Anderten can also be applied to the fuel (e.g., H_2, etc.) supplied to the cell.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to include a measuring device in the fuel cell of Jankowski, as modified by Tanaka, Keppeler and Sakai, because Anderten teaches that it provides a means with which to control the amount of fuel and reactant made available to the cell.

Double Patenting

17. The rejection of claims 1-3 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1, 4, 6, 11, 12 and 14-16 of U.S. Patent No. 7,422,816 is maintained because the terminal disclaimer, filed on January 4, 2010, does not comply with 37 CFR 1.321(b) and/or (c), as discussed above.

Although the conflicting claims are not identical, they are not patentably distinct from each other because all the elements of the instant application claims 1-3, 14 and 16 are to be found in US 7,422,816 claims 1, 4, 6, 11, 12 and 14-16 (as the instant application claims 1-3, 14 and 16 fully encompass US 7,422,816 claims 1, 4, 6, 11, 12 and 14-16) and therefore the above-described claims of US 7,422,816 anticipate those of the instant application.

Response to Arguments

18. Applicant's arguments filed January 4, 2010 have been fully considered but they are not persuasive. In sum, applicant argues the following in its remarks:

(a) "A person of ordinary skill in the art would not have been motivated to modify the fuel cell in Jankowski with the fuel absorber in Tanaka to serve as a reservoir of fuel when the initial fuel source is depleted as suggested in the Action (see Action, pg 4). ... even assuming that the fuel reservoir in Jankowski is the "initial fuel source" and that the fuel absorber in Tanaka is configured between the fuel reservoir and the electrode 25, the fuel absorber would merely function as a buffer between the fuel reservoir and the electrode 25, and not as an additional fuel reservoir. ..." (see p. 10);

(b) "...since the fuel absorber would receive all its fuel from the fuel reservoir, and since the fuel reservoir is configured as a portable fuel source, the portable operation of the fuel cell would still be limited by the quantity of fuel in the fuel reservoir, and not the fuel absorber. As a result, such a combination would not provide any additional functionality to the portable power source in Jankowski. Rather, the combination would complicate and add to the expense of the portable power source in Jankowski." (see p. 10-11); and,

(c) ... [assuming] a person was motivated to combine the teachings of Jankowski and Tanaka, such a combination still fails to teach the claimed invention. Specifically, the fuel absorber in Tanaka, which functions as a portable fuel source, would replace the fuel reservoir in Jankowski, which also functions as a portable fuel source. ... the fuel absorber would supply fuel to the electrode 25 through the manifold structure (i.e., the fuel inlet 15 and the fuel channel 29). ... at least the manifold structure would be disposed between the fuel absorber and the electrode 25. ... such a combination fails to teach the recited features of "a reservoir containing fuel disposed with the first electrode" or "where the fuel is integrated into the material of at least one of the first electrode and an adjacent layer." (see p. 11).

19. As to applicant's argument (a) – (c), it should be noted the test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference; nor is it that the claimed invention must be expressly suggested in any one or all of the references. Rather, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981).

Applicant's interpretation of the structure taught by the combination of the Jankowski and Tanaka references, and how that combination would function, it appears that applicant has disregarded the discussion of the combination of these references as presented in the previous Office Action and reproduced above. As stated in the rejections above (see Paragraph 10), "... Tanaka teaches a fuel cell,

usable in portable devices, with a fuel electrode assembly composed of a fuel electrode *surrounded by a hydrogen absorber acting as a fuel source* [emphasis added] (Abstract; para. 53, 54, 55). … It would have been obvious to one of ordinary skill in the art at the time of the invention to *incorporate a layer of material having fuel integrated therein onto an anode* [emphasis added] of the fuel cell of Jankowski because Tanaka teaches that this material can serve as a reservoir of fuel when the initial fuel source is not available (see Tanaka, para. 27, 28)." One of ordinary skill in the art would readily appreciate that there would be no need to use the hydrogen absorbed by the layer of material having fuel integrated therein onto an anode of Jankowski, as modified by Tanaka, until its initial source of fuel is depleted, as evidenced by Keppeler, US 2002/0098399 (see the Office Actions issued on August 5, 2008 and March 17, 2009 for a discussion of this reference). (Further, that artisan would also readily appreciate that "dispose" may be defined as "to put in place" or "to place, distribute, or arrange especially in an orderly way" (see "dispose" on Merriam-Webster Online Dictionary); and, thus, the reservoir of Jankowski, as modified by Tanaka, is disposed with its fuel electrode, as discussed in rejection above.) Thus, applicant's contentions are unpersuasive.

Conclusion

20. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.** See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to **Edu E. Enin-Okut** whose telephone number is **571-270-3075**. The examiner can normally be reached on Monday to Thursday, 7 a.m. - 3 p.m. (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Dah-Wei Yuan can be reached on 571-272-1295. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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